Engineering Concentration in Machine Learning (ML)

Requirements and Instructions

bu.edu/eng/programs/machine-learning/

27 November 2023

BOSTON
UNIVERSITY

Goals

Equip students with skills in:

1. **ML algorithms:**

   - select

   - adapt or optimize

   - design

   - assess performance

   - explore various application contexts

2. **ML software or hardware tools:** utilize, gain experience

3. **Data:** curate, visualize, or analyze data of various types

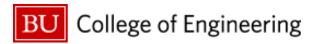4. **Communication:** read and explain methods from ML literature

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Overview

- **Concentration Declaration**

- **Coursework** (elective courses on website + slides 13, 14)
  - **1 Required overview course** (2 choices):
    - **ENG EC 414:** Introduction to Machine Learning
    - **ENG EC 503:** Learning from Data
  - **2 Elective depth courses** (26 choices across 3 pillars):
    - **Pillar I:** Models, Learning, and Inference (4 choices)
    - **Pillar II:** Optimization, Algorithms, and Programming (6 choices)
    - **Pillar III:** Applications (16 choices)

- **Experiential component**
  - **Proposal + Report + Self-Recorded Presentation**
  - **Options:** laboratory research, directed study, internships, senior design project, experiential course project, and others.

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Concentration Declaration

- **Check:** You must have a **declared major** on record

- **Declare concentration** as early as possible, but not later than **May 1 of junior year**

- **Download and complete** ML concentration declaration form from website

- **Propose** 3 courses and semesters you plan to take them:
    - 1 required
    - 2 electives
    - **no proposed course must be required for the major**
    - If a course project is proposed to satisfy the experiential component, then it must be from a course that is different from the above 3 proposed courses

- **Sign and date** the ML concentration declaration form **and submit** it to: engrec@bu.edu
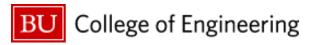
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Experiential Component

- **Options:** laboratory research, directed study, internships, senior design project, experiential course project, and others.

- If a course project is proposed for the experiential component, then it must be from a course that is different from the 3 courses used to satisfy the course-requirements of the concentration.

- **Required course:** must be completed **before** experience

- **Supervisor:** needed, e.g., faculty member at a university or a researcher in industry

- **Group projects:** individuals must contribute **substantial effort** in **lead roles** for **ML tasks**

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Experiential Component: Confidentiality Issues

- Applies to internships, lab research experiences, startups, or any situation where the work may require participating in a nondisclosure agreement (NDA).

1. Students should, at the outset, be clear with their employers that the job experience will be used to satisfy the experiential requirement.

2. Experiences involving confidentiality agreements or IP agreements are not exempt from the requirements of the proposal, report, and presentation.

3. Students should plan for, and prepare the proposal, report, and presentation to provide sufficient detail for evaluation.

4. The materials delivered to the concentration coordinator should be 'sanitized' to prevent disclosure of confidential details covered by an NDA; however, the materials must include sufficient detail to enable clear evaluation of the work and accomplishments that are relevant to the concentration.

5. The proposal and report forms must include the signature of the supervisor acknowledging they have read the materials being submitted and they approve them.

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Experiential Component: International Students

If you are an **international student** planning to use a **CPT-based internship** to complete the experiential component of the concentration, then you must successfully accomplish the following **before you can start your internship**:

- declare the concentration (see slide 4 for requirements),

- complete the required course for the concentration (EC 414 or EC 503),

- submit a proposal (see slides 8, 9 for requirements),

- obtain the following approvals and authorizations:
  1. Proposal approval: from the concentration coordinator
  2. CPT approval: from the Assistant Director of the Career Development Office
  3. ISSO authorization

- Each approval or authorization step requires some time. You must therefore alert your internship employers/supervisors to your situation and **choose a suitable start-date to ensure you have enough time to complete the above requirements**.

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Experiential Component: Proposal

- Must be submitted and approved **prior** to experience (form on website)

- Not later than **November 1**, **Senior Year**

- Required course must be completed **before** experience

- Must include name and contact information of **experience supervisor**

- If a course project is proposed, then it cannot be from the 3 courses used to satisfy the course-requirements of the concentration

- Proposed experience must:
  - Be **relevant** to ML: must connect to some **goals of concentration** (slide 2)
  - Have **substantial** ML content

- Group projects:
  - **substantial individual contribution to ML tasks** required
  - **individual proposal** required
  - discussion of **ML tasks and individual roles (lead vs support)** required

- Submit proposal-form (completed, signed & dated) + PDF document of proposal (see slide 9) to engrec@bu.edu

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Experiential Component: Proposal

- **PDF document** (up to 2 pages) describing proposed experience in **sufficient detail**. Include the following information:

    1. **Heading:** "Machine Learning Concentration Experiential Component Proposal" + Title + Your name & major + Name(s), affiliation(s) and email(s) of supervisor(s) + Name(s), major(s) and email(s) of team member(s) (for a group project) + Date

    2. **What & Why:** context + motivation + goals (ML problem statements)

    3. **How & When:** ML methods + proposed work (ML tasks) + plan (timeline)

    4. **Relevance to ML:** (connect to some **goals of ML concentration** on slide 2)

        - Data (sources, processing, labeling, analysis)

        - ML algorithms or models

        - ML software or hardware tools

    5. **Evaluation** basis for proposed work (performance metrics + what would be deemed success or failure)

    6. Suitable figures, tables, and references

    7. **Group projects:** discuss ML tasks and individual roles of all team members (identify lead and supporting roles)

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Experiential Component: Report & Presentation

- Must be submitted and approved **after** completion of experience (form on website)

- Not later than **April 22 of senior year**

- Must include **supervisor's approval** via signature on report

- Submit the following to engrec@bu.edu
  - Copy of Experiential Component Proposal
  - Summary Approval Form (completed, signed & dated)
  - PDF document of report with supervisor's signature (see slide 11)
  - PDF document of presentation slides (see slide 12)
  - Link to a self-recoded video of your presentation placed on your BU Google Drive (**include link in PDF document of presentation slides**)

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Experiential Component: Report

- **PDF document** (up to 4 pages) summarizing experience in **sufficient detail**. Include the following information:
  1. **Heading:** "Machine Learning Concentration Experiential Component Report" + Title + Your name & major + Name(s), affiliation(s) and email(s) of supervisor(s) + Name(s), major(s) and email(s) of team member(s) (for a group project) + Date
  2. **Overview:** context + motivation + goals (ML problem statements)
  3. **Contributions:** work accomplished + comparison with goals & plan in proposal
  4. **Methods of study relevant to ML:** (connect to some **goals of ML concentration** on slide 2)
     - Data (sources, processing, labeling, analysis)
     - ML algorithms or models
     - ML software or hardware tools
  5. **Evaluation** of contributions (performance metrics + discuss of success or failure)
  6. Suitable figures, tables, and references
  7. **Group projects:** discuss individual contributions of all team members related to ML tasks (identify lead and supporting roles)

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Experiential Component: Presentation

- ## Slides:
  - **Create** slides (limit 10) summarizing your experience
  - **Structure** the slides similarly to the report
  - **Submit** a PDF version of your slides together with your report

- ## Video recording:
  - Create a video recording of your slide presentation by yourself
  - The video must not be more than 5 minutes in duration
  - You must be clearly visible at the beginning of the video
  - Place the video file in **your** BU Google Drive and include a **link** to it in the PDF document of your presentation slides (on the first slide)

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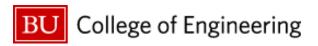
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Elective Courses

Taking courses across multiple pillars will add to the breadth and diversity of knowledge, whereas taking several courses from one pillar will provide depth within that pillar.

- **Pillar I: Models, Learning, and Inference**
  - ENG EC 418 – Introduction to Reinforcement Learning
  - ENG EC 505 – Stochastic Processes and Inference
  - ENG EC 517 – Introduction to Information Theory
  - ENG EC 523 / CAS CS 523 – Deep Learning

- **Pillar II: Optimization, Algorithms, and Programming**
  - ENG EC 525 – Optimization for Machine Learning
  - ENG EC 504 – Advanced Data Structures and Algorithms
  - ENG EC 524 – Optimization Theory and Methods
  - ENG EC 526 – Parallel Algorithms for High Performance Computing
  - ENG EC 527 – High Performance Programming with Multicore and GPUs
  - ENG EC 528 – Cloud Computing

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Elective Courses

- **Pillar III: Applications**
  - ENG BE 403 – Biomedical Signals and Controls
  - ENG BE 500 – AI and Systems Biology
  - ENG BE 500 – Deep Learning for Biomedical Images and Signals
  - ENG BE/EC 519 Speech Processing by Humans and Machines
  - ENG BE 562 – Computational Biology: Machine Learning Fundamentals
  - ENG BE 570 – Introduction to Computational Vision
  - ENG ME 404 – Dynamics and Control of Mechanical Systems
  - ENG ME 416 – Introduction to Robotics
  - ENG EK 505 – Introduction to Robotics and Autonomous Systems
  - ENG ME 570 – Robot Motion Planning
  - ENG EC 401 – Signals and Systems
  - ENG EC 402 – Control Systems
  - ENG EC 415 – Software Radios
  - ENG EC 516 – Digital Signal Processing
  - ENG EC 518 – Robot Learning
  - ENG EC 520 – Digital Image Processing and Communication

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Questions?

- Administrative:

  Undergraduate Programs & Records Office
  engrec@bu.edu

- Other:

  ML Concentration Coordinator

  Prof. Prakash Ishwar pi@bu.edu